

# Atmospheric Pressure and Wind

## Chapter 5

### Nature of Atmospheric Pressure

- Atmospheric Pressure is the force exerted by the gas molecules on some area of the Earth's surface or on any body.
- This pressure is exerted on every solid or liquid surface it touches
- It is omnidirectional, exerted equally in all directions.

### Factors Influencing Atmospheric Pressure

- Density and Pressure
  - Density is the mass of matter in a unit volume
  - The density of a gas is proportional to the pressure on it and the density of the gas is proportional to the pressure
  - Atmosphere is held to the Earth by gravity. So as the air moves away from the Earth, there is less gravity and less density, thus less pressure.
    - Higher altitude, less density, less pressure
    - Lower altitude, higher density, higher pressure

### Factors Influencing Atmospheric Pressure

- Temperature and Pressure
  - If volume is held constant
    - An increase in temperature produces an increase in pressure,
    - A decrease in temperature produces a decrease in pressure.
    - **Imagine a balloon, if it's hot, it will burst, if it's cold it deflates**
- One factor to change this (important)
  - As air rises, the molecules will spread out, so pressure does decline as does the temperature.
  - As air is compressed or altitude is lowered the molecules are compressed and the pressure is increased and the temperature increases

### Dynamic Influences on Air Pressure

- Atmospheric pressure is affected by:
  - Differences in air density
  - Air temperature
  - Air movement
- High and Low Pressures
  - Strongly descending air /with high pressure at the surface – **Dynamic high**
  - Very cold surface conditions /with high pressure – **Thermal High**
  - Strongly rising air associated with low pressure at the surface – **Dynamic Low**
  - Very warm surface conditions /with low pressure – **Thermal low**

## Mapping Pressures with Isobars

- Atmospheric pressure mapped with isobars
- Measured with Barometers
- Measurements
  - Millibars
  - Highs and Lows
  - Ridges and troughs
  - Pressure gradient

## The Nature of the Wind

- Direction of Movement
  - Pressure Gradient
    - Pressure-gradient force acts at right angles to the isobars in the direction of the lower pressure
- The Coriolis Effect
  - The Coriolis Effect deflection acts at 90 from the direction of movement, right in the north, left in the south.
- Friction
  - In lowest portions of the troposphere friction slows the wind movement, thus influencing the Coriolis Effect by reducing it.
    - Friction Layer extends only about 1000 meters above the ground.

## Cyclones and Anticyclones

- Distinct and predictable wind-flow patterns develop around all high and low pressures centers
  - Northern hemisphere
    - Low pressures – counter clockwise
    - High pressures – clockwise
  - Southern hemisphere
    - Low pressures – clockwise
    - High pressures – counter clockwise
- Wind Speed
  - If the gradient is steep, the wind speed is fast
  - If the gradient is gentle the wind speed is slow

## General Circulation of the Atmosphere

- Earth's atmosphere is a dynamic medium
  - The circulation of the atmosphere is the principal mechanism for both longitudinal and latitudinal heat transfer and global patterns of insolation as a determinant of world climates
  - Cells of circulation only exist in the low latitudes, called Hadley cells.

## General Circulation of the Atmosphere

- There are **seven atmospheric components** ranging from the equator to the pole, both north and south
  - Polar High
  - Polar Easterlies
  - Polar Front (subpolar low)
  - Westerlies
  - Subtropical high
  - Trade winds
  - Intertropical convergence zone

## Circulation of the Atmosphere

- **Subtropical Highs (STH)** Horse Latitudes
  - 30 degrees latitudes, large high pressure area over the oceans, clear, warm, calm weather
- **Trade Winds**
  - Issuing from the equator toward sides of the STHs, and toward the west, used by sailors to quickly move sailing trading ships.
- **Intertropical Convergence Zone (ITCZ)**
  - Where the northeast and southeast trade winds come together in the vicinity of the equator. Calm winds, doldrums, narrow cloud bands.
- **Westerlies ( Midlatitudes Winds)**
  - Flow west to east in the mid latitudes, 30 to 60 degrees, cover much of the earth
  - Surface Westerlies not strong, but in upper atmosphere, found in the Jet Streams
    - Polar Front Jet Stream,
    - Subtropical Jet Stream
  - Rossby Waves, waves in the jet streams towards the poles and the equator
    - Zonal and Meridional flows
- **Polar highs**– high pressures cell over Antarctic, strong and persistent. Arctic high is less predominant
- **Polar easterlies**– wind system at 60 ° latitude, moves east to west.
- **Polar front**– frontal zone in front of semi permanent lows (Subpolar low pressures) at 50 to 60° latitude, melting ground between the cold winds of the polar easterlies and the warm winds of the Westerlies

## Modifications of the General Circulation

- Monsoons
  - Disturbances in the general pattern of the circulation of the atmosphere
    - On-shore flow of winds in the summer, off shore flow in the winter
    - Seasonal precipitation; heavy in the summer; dry in the winter.
    - Found largely in the South, and Southeastern Asia and Central Africa. (India, Southeastern Asia, and Japan)
    - Economic and life preserving in these areas

## **Modification of the General Circulation**

- **Localized Wind Systems**
  - **Sea and Land Breezes**
    - Wind moving from Sea to land and back
  - **Valley and Mountain Breezes**
    - Wind moving from mountains to valleys and back
  - **Katabatic Winds**
    - Originate in cold upland area and cascade towards lower elevations
  - **Foehn/Chinook Winds**
    - Originates only with a steep pressure gradient developing on the windward side of mountains
  - **Santa Ana Winds**
    - Develop from high pressures over Rockies and rush down to California

## **El Nino- Southern Oscillation**

- An episodic atmospheric and oceanic phenomenon in the Pacific Ocean
  - Abnormally warm water appears at the surface of the ocean off the west coast of South America
    - Can Causes increased rains in northern hemisphere, less fish off the coast of South America, and drought in Southeast Asia
    - Causes not totally understood

## **Other Multi-Year Atmospheric and Oceanic Cycles**

- **Pacific Decadal Oscillation**
  - Approximately every 20 to 30 years sea surface temperatures in the northern/west tropical and eastern tropical Pacific Ocean
- **The North Atlantic Oscillation (NAO) and Arctic Oscillation**
  - The NAO – irregular “seesaw” of pressure differences between two regional components of the general atmospheric circulation of the Northern Atlantic basin
  - Arctic Oscillation alternates warm and cold phases as in the NAO.